MMA040AA Datasheet

DC–28 GHz GaAs MMIC Distributed Amplifier

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1 Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

1.1 Revision 1.0

Revision 1.0 was the first publication of this document.

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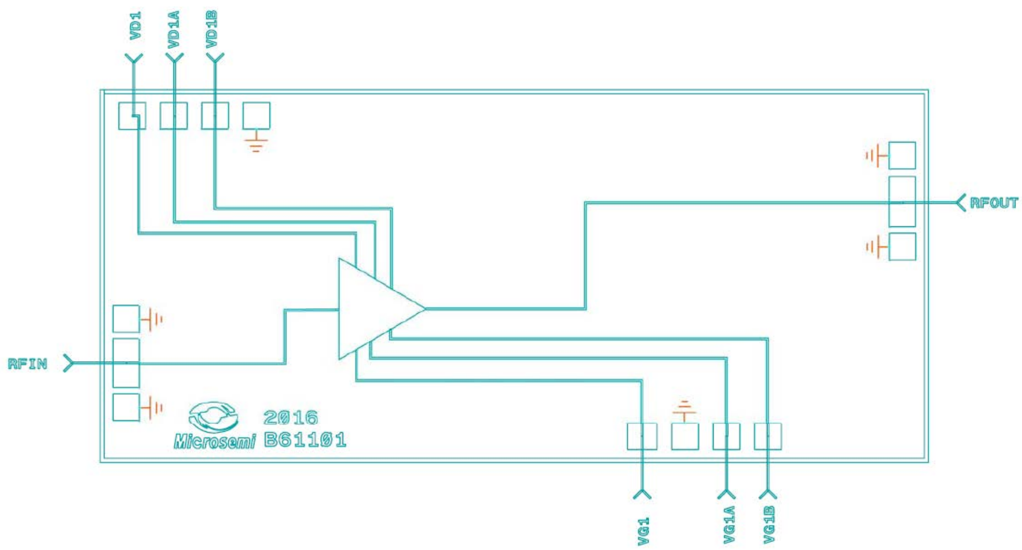
2 Product Overview

MMA040AA is a gallium arsenide (GaAs) monolithic microwave integrated circuit (MMIC) pseudomorphic high-electron mobility transistor (pHEMT) low-noise distributed amplifier die that operates between DC and 28 GHz. The amplifier provides flat gain of 16.5 dB, 2.5 dB noise figure, and 27 dBm OIP3, while requiring only 60 mA from a 8 V supply. The MMA040AA amplifier features compact die size and I/Os that are internally matched to 50 Ω, facilitating easy integration into multi-chip modules (MCMs).

2.1 Functional Block Diagram

The following illustration shows the primary functional blocks of the MMA040AA device.

Figure 1 Functional Block Diagram



2.2 Applications

The MMA040AA device is designed for the following applications:

- Test instrumentation
- Telecom infrastructure
- Microwave radio and VSAT
- Microwave communications

2.3 Key Features

The following are key features of the MMA040AA device:

- Frequency range: DC to 28 GHz
- Flat gain: 16.5 dB
- High IP3: 27 dBm

- Low noise: 2.5 dB at 10 GHz
- Supply voltage: 7 V at 60 mA
- 50 Ω matched I/O
- Compact die size: 3 mm × 1.32 mm × 0.1 mm

3 Electrical Specifications

3.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MMA040AA device.

Table 1 Absolute Maximum Ratings

Parameter	Rating
Storage temperature	–65 to 150 °C
Operating temperature	–55 to 85 °C
Drain bias voltage, (V_D)	9 V
Gate bias voltages, (V_{G1} and V_{G2})	–2 to 0.5 V
V_D current (I_{DD})	300 mA
RF input power	22 dBm
DC power dissipation (T = 85 °C)	1.1 W
Channel temperature	150 °C
Thermal impedance	60 °C/W
ESD sensitivity (HBM)	

3.2 Typical Electrical Performance

The following table shows the typical electrical performance of the MMA040AA device at 25 °C, where V_{DD} is 8 V and I_{DD} is 60 mA. All measurements are derived from the RF probed die according to the assembly diagram shown in section 4.4, unless otherwise indicated.

Table 2 Typical Electrical Performance

Parameter	Frequency Range	Min	Typ	Max	Units
Operational frequency range		DC		28	GHz
Gain	DC–6 GHz	15.5	16.5		dB
	6 GHz–12 GHz	15.5	16.5		dB
	12 GHz–20 GHz	15.5	16.5		dB
Gain flatness	DC–6 GHz		±0.2		dB
	6 GHz–12 GHz		±0.2		dB
	12 GHz–20 GHz		±0.2		dB
Gain variation over temperature	DC–6 GHz		0.007		dB/°C
	6 GHz–12 GHz		0.007		dB/°C
	12 GHz–20 GHz		0.017		dB/°C
Noise figure	DC–6 GHz		2.5	3	dB
	6 GHz–12 GHz		2	2.5	dB
	12 GHz–20 GHz		3	3.5	dB
Input return loss	DC–6 GHz		15		dB
	6 GHz–12 GHz		15		dB
	12 GHz–20 GHz		12		dB
Output return loss	DC–6 GHz		12		dB
	6 GHz–12 GHz		15		dB
	12 GHz–20 GHz		18		dB
P1dB	DC–6 GHz	15	16		dBm
	6 GHz–12 GHz	15.5	16		dBm
	12 GHz–20 GHz	14	15		dBm
Psat	DC–6 GHz		17		dBm
	6 GHz–12 GHz		18		dBm
	12 GHz–20 GHz		17		dBm
OIP3	DC–6 GHz		27		dBm
	6 GHz–12 GHz		27		dBm
	12 GHz–20 GHz		27.5		dBm
V_{DD} (drain voltage supply)			7		V
I_{DD} (drain current)			150		mA

3.3 Typical Performance Curves

The following graphs show the typical performance curves of the MMA040AA device at 25 °C, unless otherwise indicated.

Figure 2 Broadband Gain (V_{DD} = 8 V, I_{DD} = 60 mA, T = 25 °C)

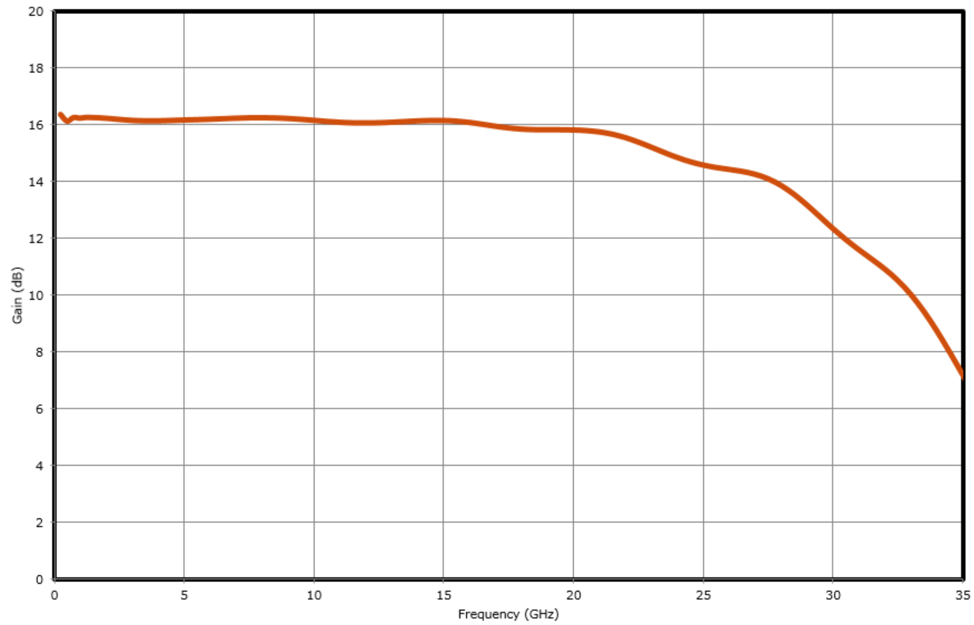


Figure 3 Gain vs. Temperature (V_{DD} = 8 V, I_{DD} = 60 mA)

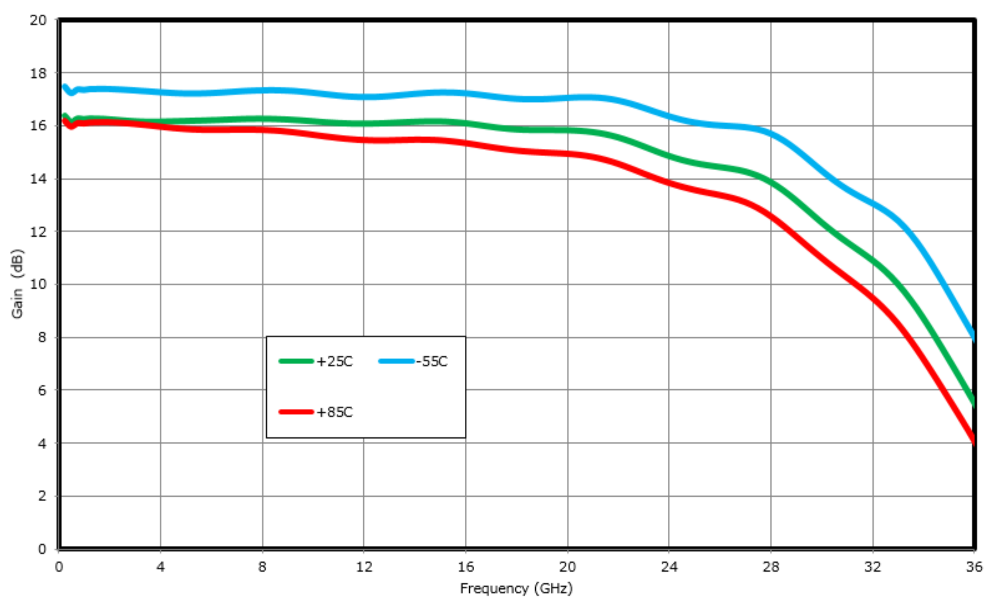


Figure 4 Gain vs. V_{DD} (I_{DD} = 60 mA, T = 25 °C)

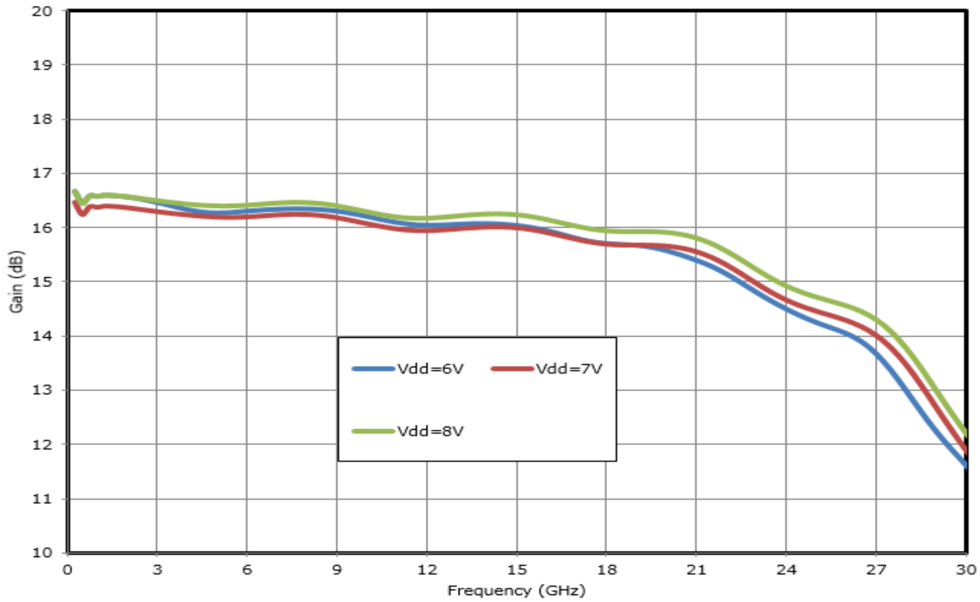


Figure 5 Gain vs. I_{DD} (V_{DD} = 8 V, T = 25 °C)

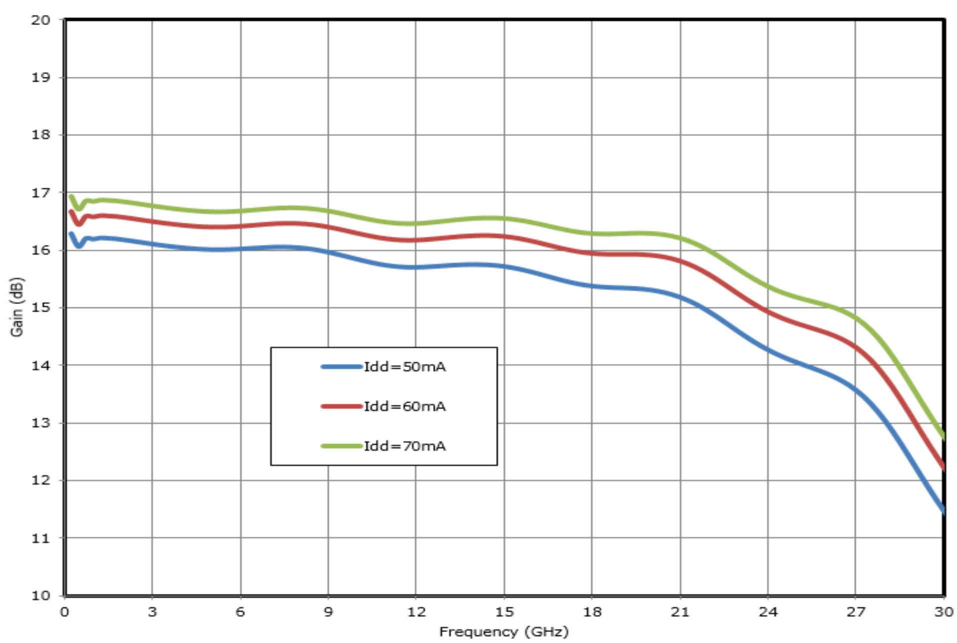


Figure 6 Input Return Loss (V_{DD} = 8 V, I_{DD} = 60 mA, T = 25 °C)

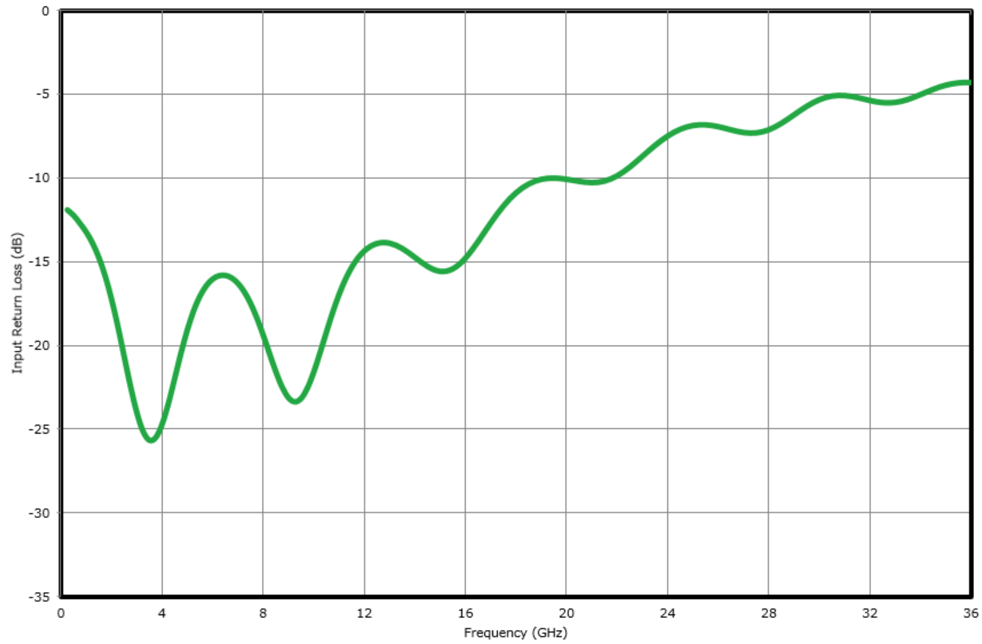


Figure 7 Input Return Loss vs. Temperature (V_{DD} = 8 V, I_{DD} = 60 mA)

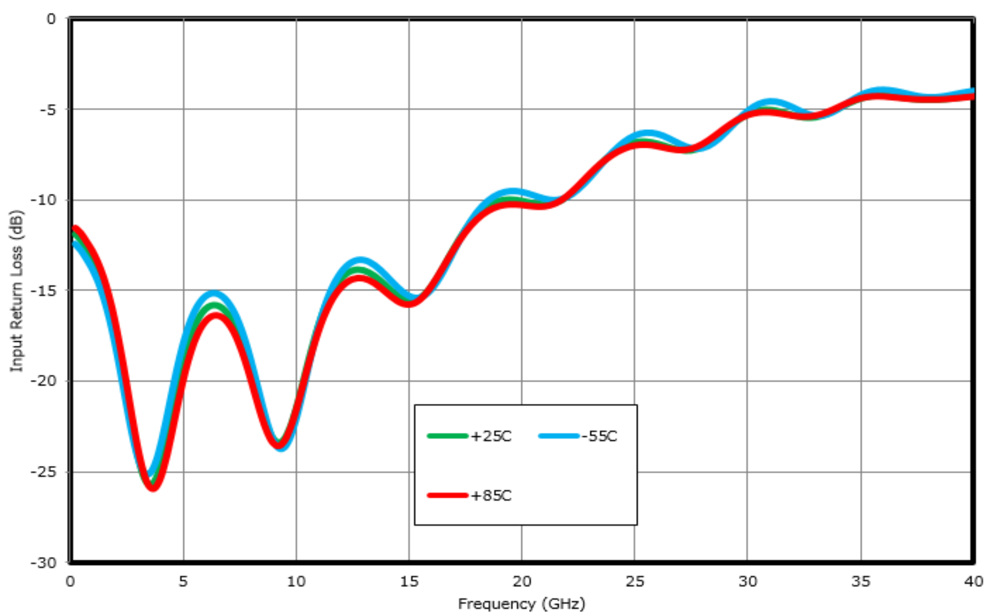


Figure 8 Output Return Loss (V_{DD} = 8 V, I_{DD} = 60 mA, T = 25 °C)

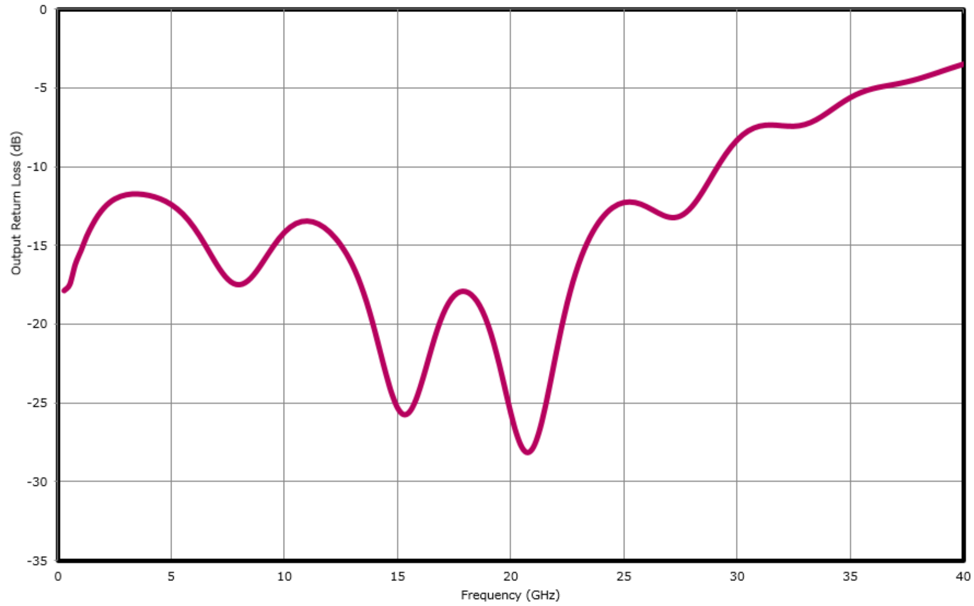


Figure 9 Return Loss vs. Temperature (V_{DD} = 8 V, I_{DD} = 60 mA, T = 25 °C)

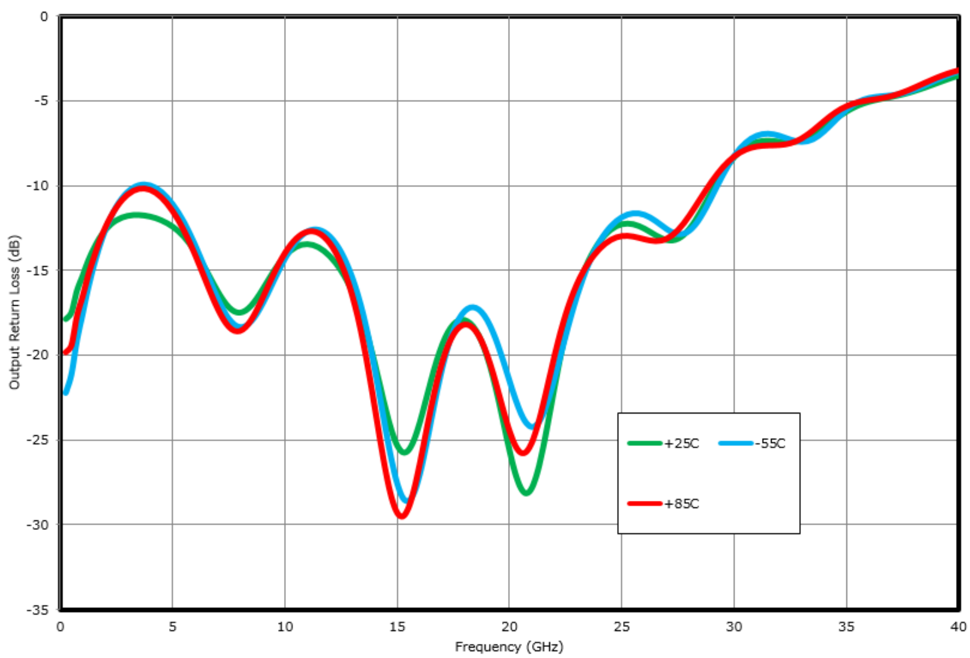


Figure 10 Noise Figure vs. Temperature (V_{DD} = 8 V, I_{DD} = 60 mA, T = 25 °C)

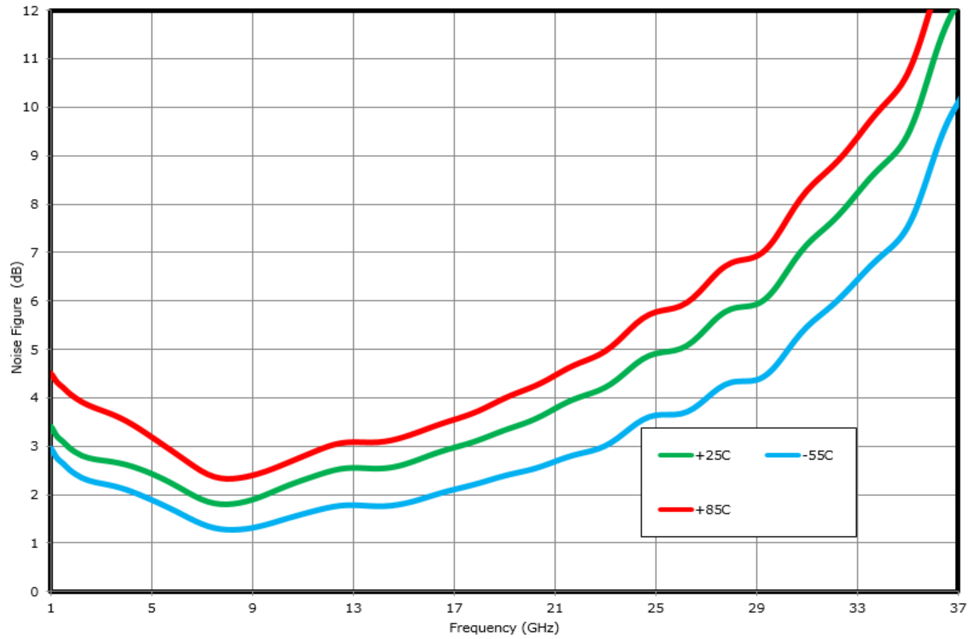


Figure 11 Noise Figure vs. V_{DD} (I_{DD} = 60 mA, T = 25 °C)

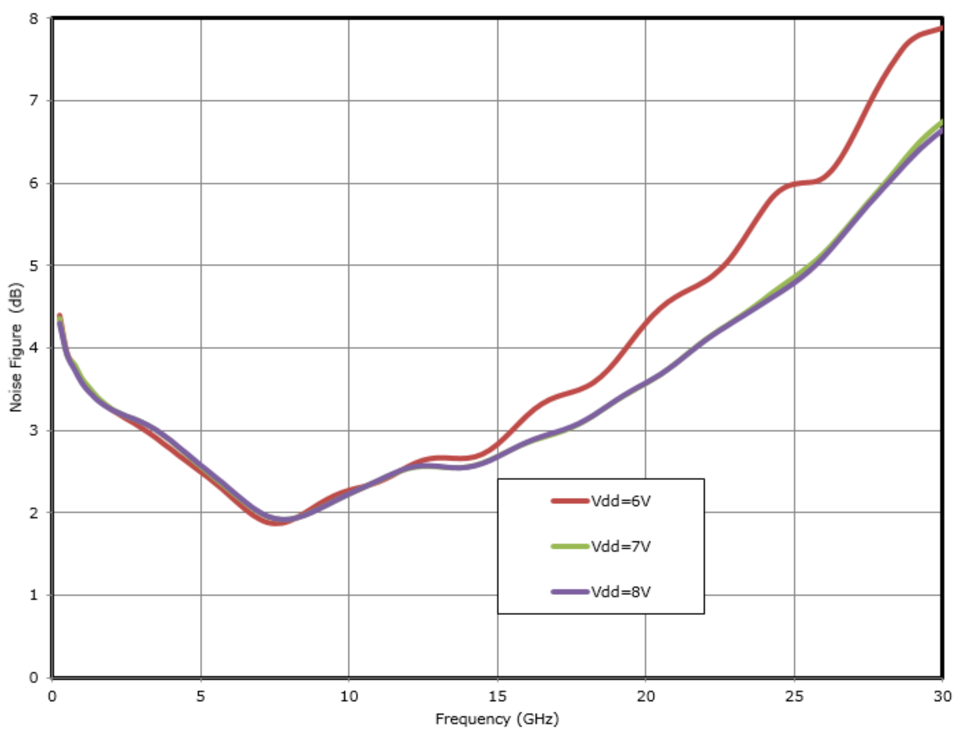


Figure 12 Noise Figure vs. I_{DD} (V_{DD} = 6 V, T = 25 °C)

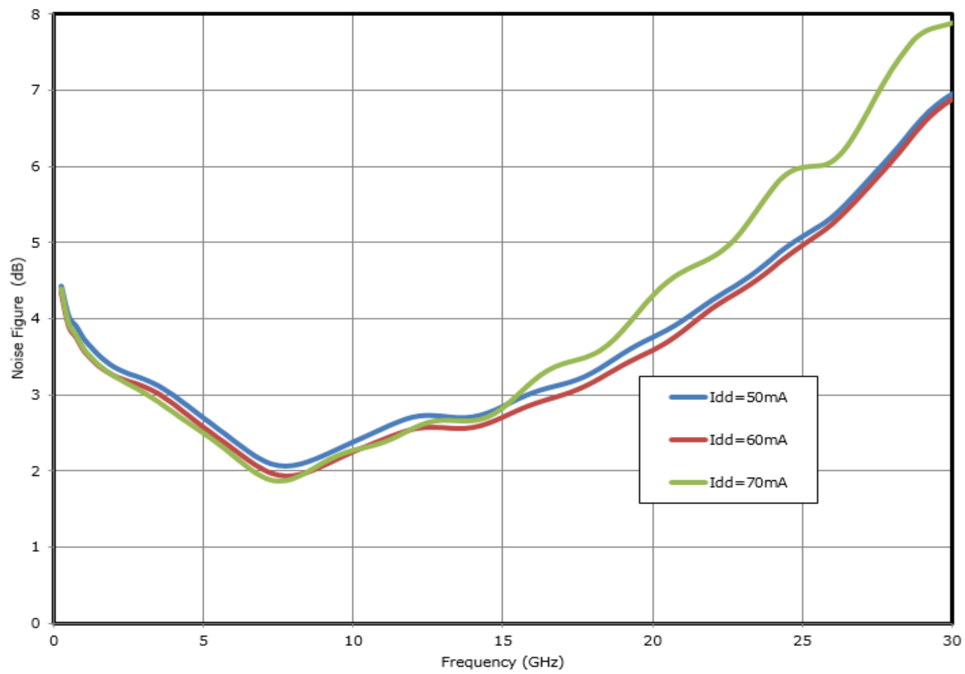


Figure 13 P1dB Output Power vs. Temperature (V_{DD} = 8 V, I_{DD} = 60 mA, T = 25 °C)

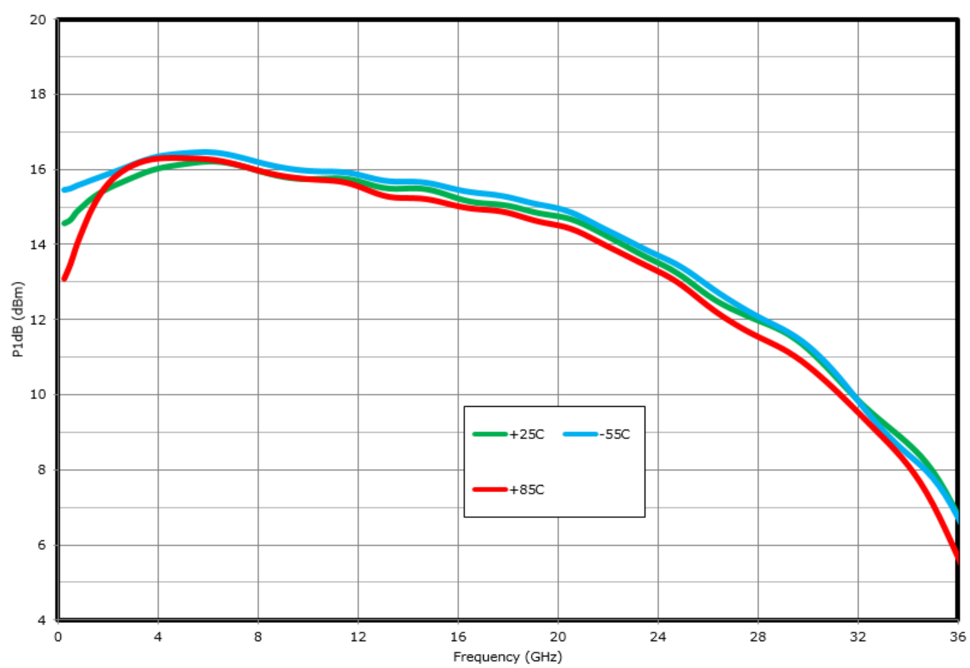


Figure 14 P1dB Output Power vs. V_{DD} (I_{DD} = 60 mA, T = 25 °C)

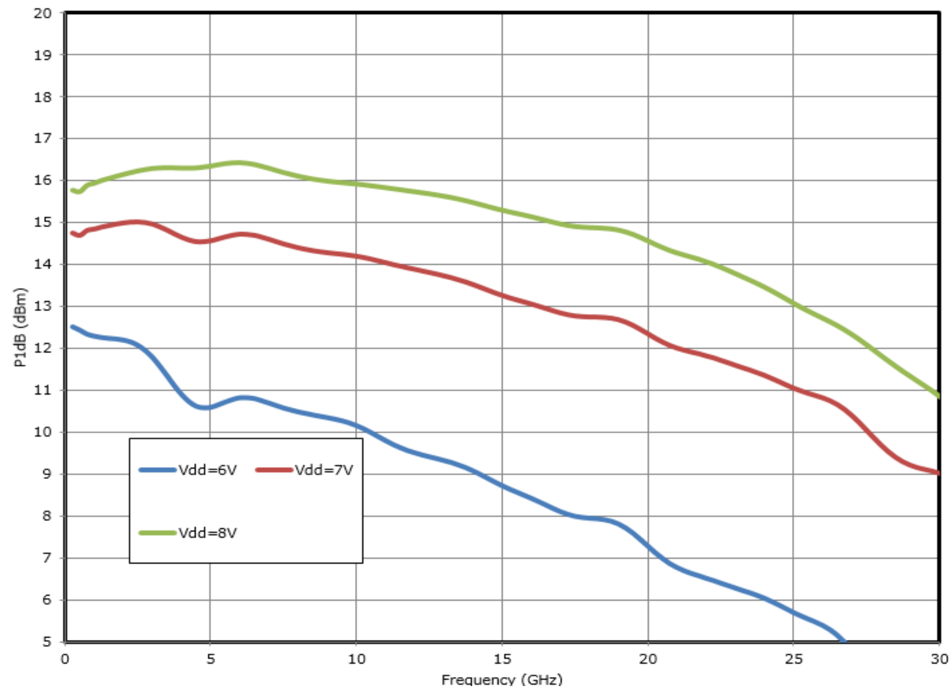


Figure 15 P1dB Output Power vs. I_{DD} (V_{DD} = 8 V, T = 25 °C)

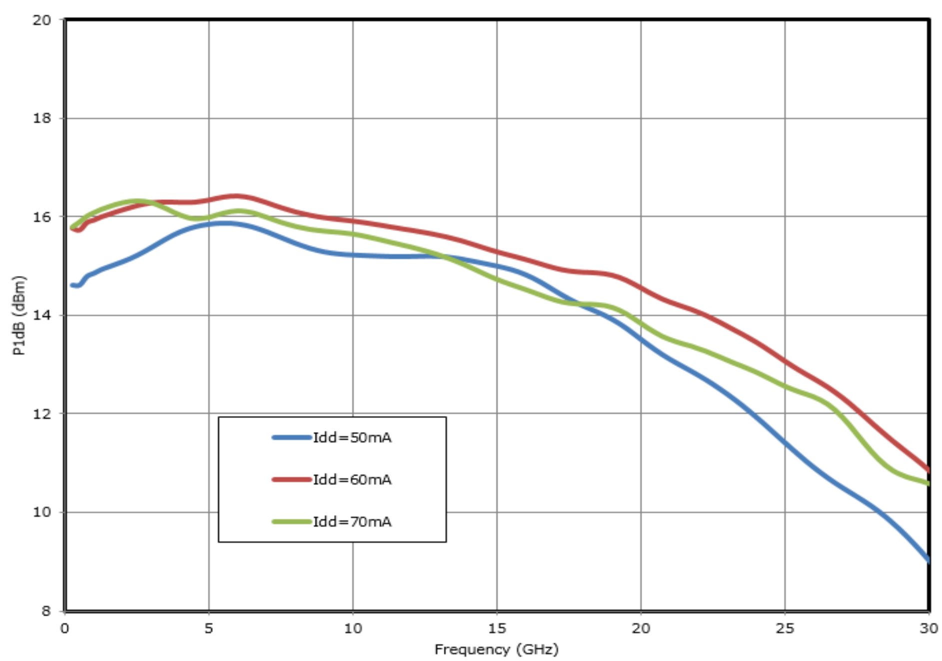


Figure 16 Output IP3 vs. Temperature (V_{DD} = 8 V, I_{DD} = 60 mA)

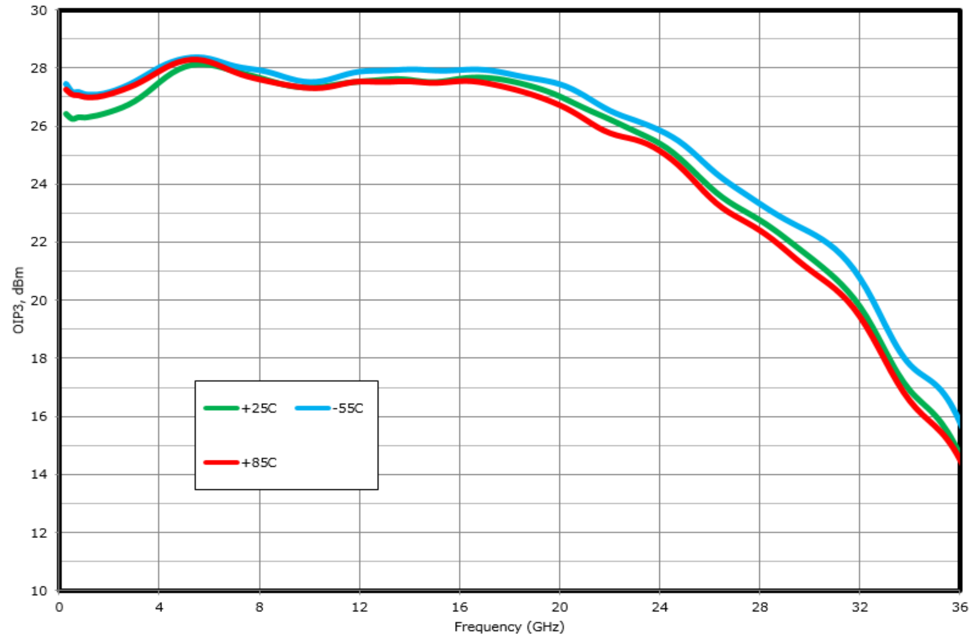


Figure 17 Output IP3 vs. V_{DD} (I_{DD} = 60 mA, T = 25 °C)

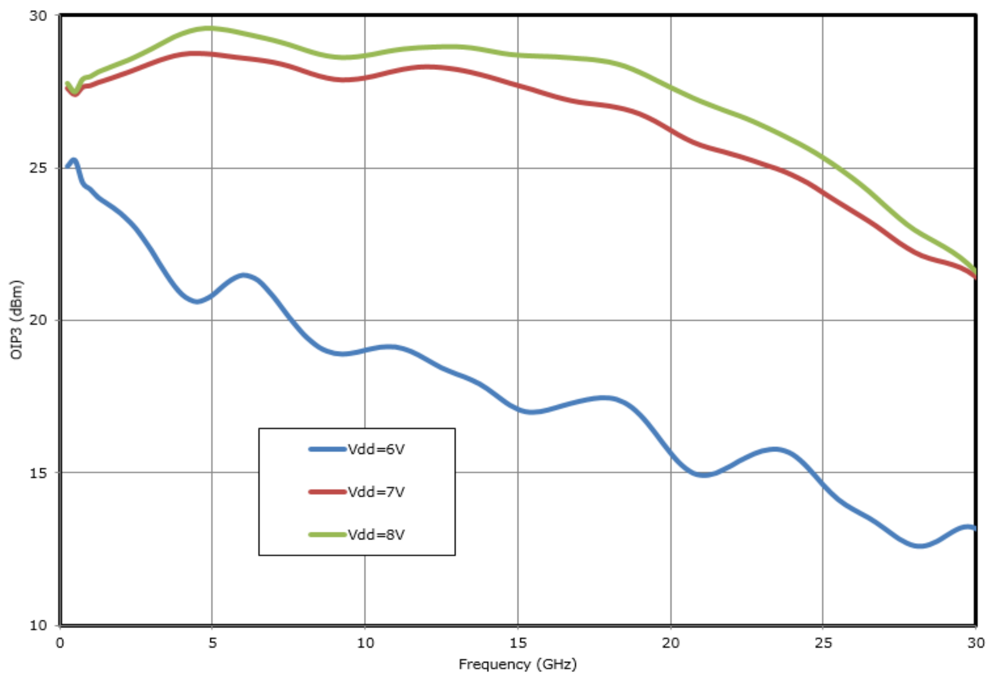
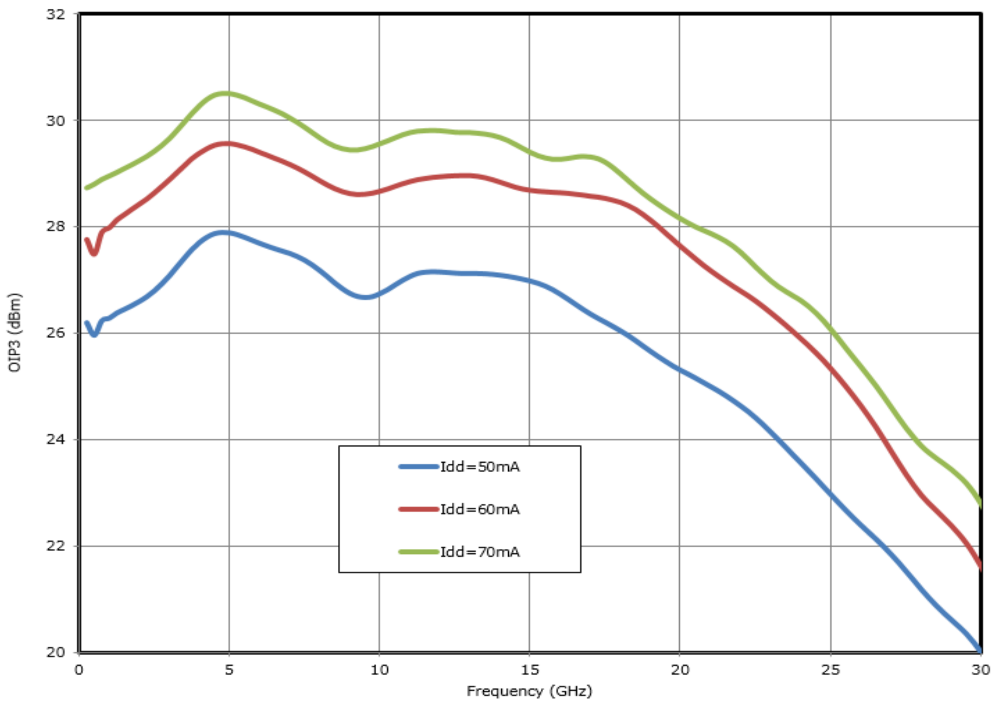


Figure 18 Output IP3 vs. I_{DD} (V_{DD} = 8 V, T = 25 °C)

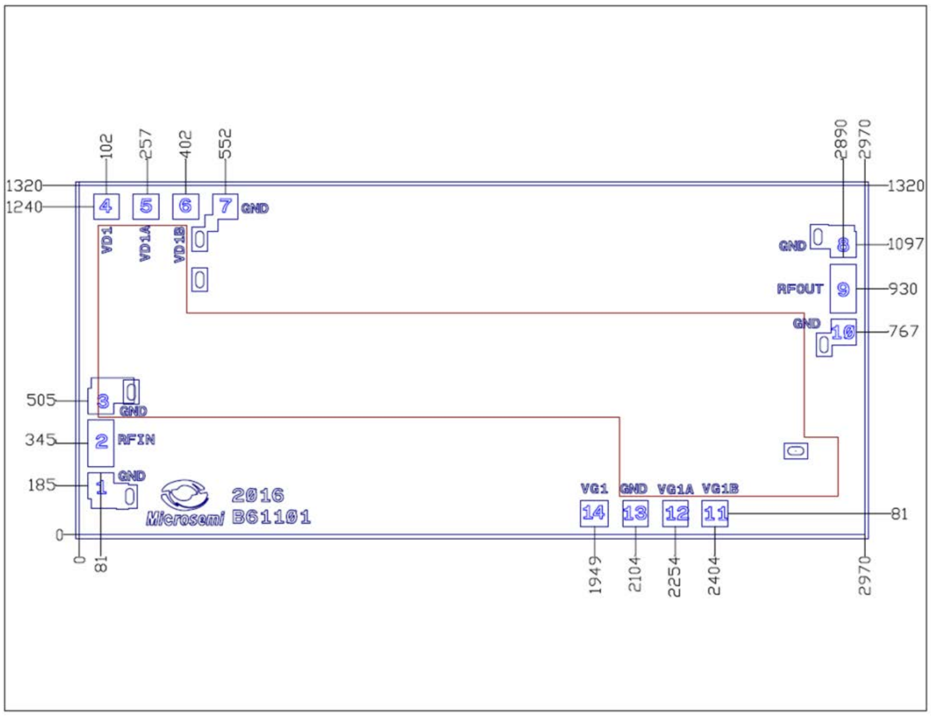


4 Chip Outline Drawing, Die Packaging, Bond Pad, and Assembly Information

4.1 Chip Outline Drawing

The following illustration shows the chip outline of the MMA040AA device. Dimensions are in µm and are relative to the zero datum locations shown in the drawing. The minimum bond pad size is 100 µm × 100 µm. Both the bond pad surface and the backside metal are 3 µm gold. The die thickness is 100 µm. The backside is the DC/RF ground. The airbridge keepout region is in crosshatch, and the unlabeled pads should not be bonded.

Figure 19 Chip Outline



4.2 Die Packaging Information

The following table shows the chip outline of the MMA040AA device. For additional packaging information, contact your Microsemi sales representative.

Table 3 Die Packaging Information

Standard Format	Optional Format
Waffle pack	Gel pack
50–100 pieces per pack	50 pieces per pack

4.3 Bond Pad Information

The following table shows the bond pad information of the MMA040AA device.

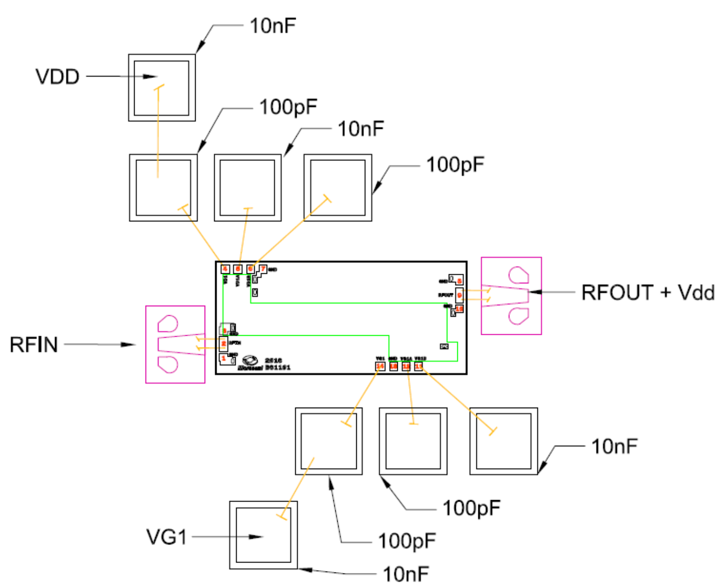
Table 4 Bond Pad Information

Bond Pad Number	Bond Pad Name	Description
1, 3, 7, 8, 10, 13	GND	Die bottom must be connected to RF/DC ground.
2	RFIN	This pad is DC-coupled and matched to 50 Ω.
4, 5, 6	VD1, VD1A, VD1B	Power supply voltage for the amplifier. External bypass capacitors are required.
9	RFOUT	This pad is DC-coupled and matched to 50 Ω.
14, 12, 11	VG1, VG1A, VG1B	Gate control for amplifier. Adjust to achieve I_{DD} = 60 mA.
Backside paddle	RF/DC GND	RF/DC ground.

4.4 Assembly Diagram

The following figure shows the assembly diagram of the MMA040AA device. In the die test assembly shown, both RFIN and RFOUT ports should utilize bias tees or DC blocks to isolate external circuits from the IC. V_{DD} to the MMA040AA die is supplied through DC bypass caps of >10 nF (the actual value depends on the low-frequency bandwidth requirements of the application).

Figure 20 Assembly Diagram



5 Handling and Die Attachment Recommendations

Gallium arsenide integrated circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. It is recommended to follow all procedures and guidelines outlined in the Microsemi application note AN01 GaAs MMIC Handling and Die Attach Recommendations.

6 Ordering Information

The following table shows the ordering information for the MMA040AA device.

Table 5 Ordering Information

Part Number	Package
MMA040AA	Die